This white paper is the fifth in a five-part series dedicated to examining problems organizations encounter when operating in multimodel environments and the current process improvement approaches such organizations need to consider.

Implementation Challenges
in a
Multimodel Environment

Pat Kirwan, Jeannine Siviy, Lisa Marino, and John Morley
May 2008

Software Engineering Institute | **Carnegie Mellon**

Report Documentation Page		*Form Approved* *OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **MAY 2008**	2. REPORT TYPE	3. DATES COVERED **00-00-2008 to 00-00-2008**
4. TITLE AND SUBTITLE **Implementation Challenges in a Multimodel Environment**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Carnegie Mellon University ,Software Engineering Institute (SEI),Pittsburgh,PA,15213**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**16**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Acknowledgments

About this series

This white paper is the fifth in a five-part series dedicated to examining problems organizations encounter when operating in multimodel environments and the current process improvement approaches such organizations need to consider. It addresses the implementation challenges faced by process improvement professionals in multimodel environments, where it becomes necessary to coordinate roles and responsibilities of the champions for different technologies, to integrate and coordinate training, to optimize audits and appraisals, and develop an integrated approach to project portfolio management.

The rest of this series addresses, in more detail, each phase of the reasoning framework for technology harmonization in a multimodel environment:

- The 1st white paper addresses the benefits of a harmonized approach when implementing more than one improvement model, standard, or other technology and provides a high-level description and underlying paradigms of a reasoning framework for technology harmonization.

- The 2nd white paper examines the approaches needed in technology selection including a strategic taxonomy, the decision authorities associated with that selection at all levels in the organization, and considerations for thoughtful sequencing of implementation in alignment with the organizations' mission, goals and objectives.

- The 3rd white paper examines technology composition in relation to the concepts introduced in the previous white papers; a proposed element classification taxonomy to make technology integration effective in practice; and the role of technology structures, granularity and mappings in technology composition.

- The 4th white paper examines the current state of the practice for defining process architecture in a multimodel environment, methods and techniques used for architecture development, and underlying questions for a research agenda that examines the relationship of technology strategy and composition to process architecture as well as the interoperability and architectural features of different process technologies.
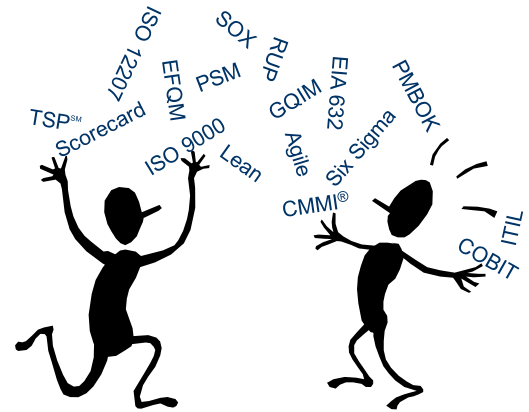
A multimodel process improvement environment has significant implications for an organization's improvement infrastructure and for the way in which new technologies[1] or changes to the existing technology mix are deployed in the organization. This white paper addresses the implementation challenges faced by process improvement professionals in multimodel environments:

- Establish a coordinated process improvement infrastructure
  - coordinate roles and responsibilities of the champions for different technologies
  - integrate and coordinate training
- Develop of an integrated approach to improvement project portfolio management
- Optimize of audits and appraisals
- Establish aligned measurement systems (which provides additional benefits, such as integration and governance motivation)

PROCESS IMPROVEMENT INFRASTRUCTURES

The organizational structures established to support the achievement of organizational excellence are as varied and diverse as the organizations themselves. This diversity is, in general, positive, reflecting the adaptation of organizational structure to the specific business context. While the organization structures for process improvement are diverse, there are common patterns that have proven themselves in many improvement initiatives and are recognizable in most organizations and indeed in many improvement technologies. We will discuss these common patterns and the adjustments needed for successful implementation in a multimodel context.

There are three common organizational roles in structures for process and product improvement. In relation to individual improvement technologies being adapted, these are:

- Senior management who provide sponsorship, budget, and strategic direction to the improvement efforts of the organization. This may be in the form of a steering group or it may be built into the responsibilities of individual managers.
- Personnel to facilitate and co-ordinate process and product improvement in the organization. Often personnel are organized around or charged with a particular improvement technology.
- Improvement teams that are temporary in nature, implementing specific improvement as directed by the senior management and the improvement personnel.

Ideally, these three organizational roles are staffed with influential and respected individuals who are experienced in the operative realities of the organizations business. In larger organizations, these roles may be repeated in a complex multi-layered hierarchy that also might be very geographically diverse. Of course, these are

---

[1] In this series of white papers, we use the terms *improvement technologies*, *technologies*, or *models* somewhat interchangeably as shorthand when we are referring in general to the long list of reference models, standards, best practices, regulatory policies, and other types of practice-based improvement technologies that an organization may use simultaneously.

just the basic, common components. The reality is somewhat more complex. Some improvement technologies provide guidance for the infrastructure necessary to implement and sustain improvement in an organization:

- The Carnegie Mellon® Software Engineering Institute's Capability Maturity Model® Integration (CMMI®) recommends the establishment of management steering committees, process groups, process action teams and process owners as best practice when focusing on process at an organizational level [Chrissis 2006].

- Six Sigma infrastructures are a core aspect of its codified deployment element, including adoption decisions and advocacy from executive level, champions who select projects and remove barriers, and implementation improvement through a network of trained experts called "Black Belts," or "Belts," for short. Belts shoulder the majority of improvement project leadership, with Master Black Belts taking responsibility for large or very complex (or highly specialized) projects. Green Belts may lead smaller projects, but often serve on project teams, along with subject matter experts, domain experts and other cross-functional representatives.

Despite the similarity in structures typically established by different improvement technologies, the reality is that champions of each technology establish their own improvement organization, with duplication of similar functions and with consequent cost duplication to the organization as a whole.

Organizations often arrive at the realization that they are in a multimodel environment over a period of several years. For example, the engineering group starts a CMMI-based improvement and establishes the typical CMMI infrastructure to implement change. A new executive level manager arrives from an organization using Six Sigma and begins a corporate Six Sigma initiative, including the organizational structure needed to support it. It is often only when conflict and friction between these (and potentially many more) groups surfaces that the organization realizes it is has parallel, overlapping, and competing organizational structures. All of those structures generate costs and all try to improve some aspect of the organization's performance. The pain these circumstances cause argues strongly for a harmonization of the structures supporting organizational improvement.

Our research has shown that organizations succeeding with multimodel environments work to optimize their improvement infrastructures. Such optimization may include:

- the establishment of integrated structures across multiple improvement technologies

- a systematic distribution of responsibilities across improvement technology structures for strategic, tactical or domain related improvement or a combination of these

Shared and coordinated roles and responsibilities

Organizations in multimodel improvement environments need to consider having the respective improvement technology experts work in the same teams, share roles or identify other means of establishing a seamless partnership. The objective is for the champions and implementers of different technologies to have a shared sense of organizational mission and goals and a shared sense of responsibility for establishing a successful integrated process improvement program that achieves all of their objectives

There is a strong case for a systematic integration of change agents in cross-technology improvement structures, whether these are permanent or temporary in nature. This cross-technology sharing and coordination of roles may take different forms both from the type of cooperation established and the temporal nature of the structures established. For example, where change control boards are considering the introduction of new or changed technologies into the technology mix implemented in an organization, these bodies should typically be permanent and staffed with cross-technology experts who are empowered to make relevant decisions. In contrast, teams of cross-technology experts, assembled for the implementation of specific improvements are often of temporary nature.

A good example of how roles can be shared and coordinated is afforded by two technologies we have studied in practice: CMMI and Six Sigma. For example, when looking for candidates to train as Six Sigma Belts, an organization should consider Engineering Process Group members. Six Sigma champions need to understand (or at least have awareness) of CMMI and other discipline specific technologies.

Another consideration for identifying shared roles and responsibilities is to leverage the codified best practices available for just this sort of purpose. As an example, the CMMI is a useful source of good practices for the establishment and maintenance of effective integrated teams [CMMI-DEV v1.2]. To successfully integrate technologies and improvement infrastructures within an organization, decision makers need to consider how to develop a sense of shared vision in those with responsibility for improving organizational excellence. The development of a common "understanding of the organizational mission, goals, expectations and constraints allows the project to align its direction, activities, and shared vision with the organization and helps create a common purpose within which project activities can be coordinated" [Siviy 2007].

The CMMI stresses that teams and functional experts cannot operate effectively in isolation. Developed specifically for teams developing products, the CMMI for Development constellation using integrated product and process development practices (IPPD) can equally well be applied to those having to work together effectively in integrating improvement technologies. The CMMI also stresses that an effective communication strategy is critical to implementing and focusing on the shared vision. This aspect, too, is applicable in the context we are addressing. In addition, the CMMI gives useful guidance on how to establish and maintain relevant team structures when working in a collaborative and coordinated manner, which we believe is also critical to success in process improvement in a multimodel context.

Integrated and coordinated training

Having translated our organizations mission to inform improvement strategy (see the 2nd white paper in this series) and established coordinated organizational structures to support multimodel process improvement, we need to consider how to improve the operational effectiveness of the resultant shared roles and responsibilities and associated collaborations. Integrated and coordinated training is one of the mechanisms we recommend to help improve the effectiveness.

Integrated/coordinating training might include such things as

- *All change agents, champions and improvement professionals receive awareness level training about all selected technologies*

  It is vitally important for improvement technology experts, especially the change agents for each improvement technology, to development an adequate understanding of the details of the technologies that need to be integrated and interoperable within an organization. There are two pertinent reasons for requiring this cross-technology awareness and competence. This knowledge is essential if change agents are to work together effectively in the mission translation and model composition tasks explained in the 3rd white paper of this series. While considering, for example, the impact of change proposals, members of a change control board need to be aware of the manner in which currently integrated technologies work together and the consequences of any proposed changes. This requires the establishment of effective cross-technology team structures and cross-technology competence among the different technology change agents. In addition, without an appreciation for the affinity and granularity relationships of the different technologies, an effective coordination and cooperation of different technology change agent will be difficult to achieve.

- *Selected improvement professionals receive in-depth technology training in each selected technology; consider training some individuals in more than one technology to help bridge communications gaps, understand the technical links between technologies, and so on.*

  There is still a need to train improvement professionals in the organization in the individual source technologies and to provide training in how the source technologies are related and connected. The improvement professionals need to develop a deep understanding of these source technologies, plus, the organization should provide supplemental training that focuses on important strategic and tactical relationships between the source technologies. Organizations may develop such a training delivery competence in-house, supported by a growing research literature in this area. Some outsourced training provisioning is also beginning to become available [Siviy 2007].

- *All system and software developers receive awareness or in-depth training about selected technologies; this training is primarily in the organizations standard process, but likely includes discipline-specific, tactical technologies.*

  Organizations that have established an integrated process architecture, which places focus on the executed processes, are acutely aware that operative staff needs to be trained in the executed process and not in the various source technologies that were used as input for the executed process. The cost savings organizations can realize by training their project and operative staff in the implemented version of the organizations processes—not in a broad range of source technologies—are significant. That is not to say that orientation and awareness training for specific roles that need to understand the relationship of the changes planned to the relevant source models should not be undertaken. Management roles that need to support the rollout of changes in the organization through a focused customization of the rewards and recognition system should receive this kind of training, for example. Overall, training large numbers of staff in the details of the source technologies may lead to a broad understanding of the terminologies used in these technologies in the organization, but these benefits must be balanced against very considerable costs in most cases. As a rule, large scale training in the source technologies is not recommended.

To achieve cross-technology awareness and competence at each of the described levels, organizations need to find effective ways of cross-training experts in individual improvement technologies from the suite of improvement technologies relevant to the organization. The competence management system in organizations needs to adjust its objectives and approaches to ensure that individual experts in single technologies receive cross-training in other relevant technologies to the degree required for the roles they have in the organization.

Pairing of CMMI and Six Sigma

Some CMMI experts may require training in Six Sigma to help them understand how Six Sigma helps achieve a quantitatively managed process, while others will need a level of training allowing them to work on teams charged with implementing quantitatively managed processes. Six Sigma Black Belts may require introductory training in CMMI to understand the architecture of the model and to understand the software and systems engineering domain the model is typically applied in. Other Six Sigma experts may require training that is more fundamental in the systems engineering domain. Both Six Sigma and CMMI experts may require a common CMMI-Six relationship training. This type of supplementary cross-domain training is common practice in some organizations. The types of training consideration just discussed for Six Sigma and CMMI are by no means comprehensive (see Siviy 2007 for a more detailed discussion). These inter-relationships and related cross-training should be addressed for all relevant improvement technologies in the organization. Not addressing these in training or not understanding the inter-relationships adequately, before developing or outsourcing cross-training, can be costly in terms of the expenditure wasted. Additional costs may arise down the line as a consequence of decisions made based upon seriously deficient cross-technology competence and awareness. There is therefore a strong business case to be made for a systematic and professional approach to the cross-training of experts from the individual improvement technologies implemented in an organization.

COORDINATED IMPROVEMENT PROJECT PORTFOLIO MANAGEMENT

In their article "How the Learning Organization Manages Change" Ronald Recardo, Kathleen Molloy, and James Pellegrino make the important observation that the translation of organizational goals and related metrics to the teams and individuals responsible for effecting change in the organization is one of the most significant barriers to successful process improvement [Recardo et al. 2007]. Those charged with managing and driving process improvement in the organization have to ensure traceability between the organizations' mission and goals and the improvement activities planned and executed in the organization. In a multimodel environment the mission translation activities are a critical activity, needing to guide technology selection, informing how the different technologies can be combined effectively and providing key inputs to the selection of success measures for the improvement efforts. A systematic approach to these activities is advisable, as this will help ensure objectivity of the staff performing these activities. In addition mission translation critically informs the decisions required to ensure the design of an effective coordination of improvement project portfolio management. Even where mission translation and goal decomposition is performed, the number of potential improvement related tasks or projects from the various source technologies addressed in an organization can be quite large. There are, in addition, many other sources of improvement suggestions, including ideas generated from lessons learned feedbacks from operational projects, appraisal results and lists of items from various types of gap analyses. Thus an organization will typically have several extensive lists of items that might be improved and these may be separate and competing. A systematic coordination and prioritization of these lists and the improvement projects derived from them is needed. The use of Six Sigma and other methodologies to understand the voice of the customer, the voice of the business and the voice of the process helps inform the prioritization undertaken. This prioritization should include enabling projects which can be better justified with an understanding of the "voices" relevant to the organization.

These mission translation activities are prerequisites for an effective implementation of improvement projects at different levels in the organization, addressing individual or integrated improvement technologies across an extended period. The requisite sequencing, major dependencies and constraints of inter-related improvement project need to be addressed effectively by those charged with managing improvement in the organization. A seamless synchronization of improvement projects that are aligned with the mission, goals and objectives of the organization necessitates the establishment of a coordinated improvement project portfolio management. We define coordinated improvement project portfolio management as the set of

approaches used for prioritizing and collectively managing all current or future improvement projects based on characteristics derived from a sound understanding of the organization's mission. Its goal is thus to determine the optimal mix and sequencing of proposed projects to best achieve the organization's misson. The risks associated with not implementing improvement project portfolio management are manifold, including internal competition for scarce improvement related funding, the establishment of divergent and competing improvement technology project structures including different reporting and communication channels. This risk is heightened where individual improvement technology initiatives engage in gap analysis of the organization against their own technology. If an overarching and effective improvement project portfolio management is not in place, the activities resulting from the gap analysis will be uncoordinated with other activities in the organization. Properly embedded in the improvement project portfolio management system however, the individual gap analyses provide an important input to the totality of all improvement activities in the organization. Thus top-down and bottom-up approaches to the identification of improvement activities is supported by the implementation of a improvement project portfolio management.

In a non-harmonized approach, improvement projects can be isolated from each other and from the overall organizational mission. Goal decomposition, as we said in the 2nd white paper of this series, gives all improvement projects a line of sight to the topmost organizational goals and an explicit relationship to one another. Such methods can be incorporated into the organizational standard processes for identifying and defining projects. The integrated improvement project portfolio that arises from a harmonized multimodel approach also gives the organization an understanding of the role of "enabling" projects in establishing processes and measures needed for subsequent improvement efforts that have direct bottom line benefit. Enabling projects establish required infrastructure, processes or measurement systems that subsequent improvement projects will utilize, but themselves have no direct contribution to bottom-line savings. The economic justification of such enabling projects is easier in a harmonized multimodel approach, where the inter-relationships between improvement technologies and the improvement projects launched to implement them are well understood.

Enablers for a coordinated improvement portfolio management include the shared roles, improvement infrastructure and cross-training discussed earlier in this paper. With these in place we have a skilled, integrated and synchronized improvement workforce that are well equipped to manage the balancing of different interest, needs and expectation of the many and varied stakeholders an organization has in relation to improvement projects.

COORDINATED AUDIT AND APPRAISAL PROCESS

The activities that organization need to perform to reduce the risk inherent in process improvement and operations in multimodel improvement environments are outlined over the course of this series of white papers. Given that an organization has aligned the improvement effort with the mission and business objectives of the organization, has performed a systematic approach to model selection and composition, and has successfully deployed the resulting organizational processes with aid of a robust process architecture, there are still barriers to reaping the full potential from all this effort. One of the most significant barriers manifests itself out of the cost to, and disruption of, operational activities resulting from the requirement to demonstrate compliance to the multitude of source technologies, now embedded in the organizations own implemented process. Many technologies come with an obligation to appraise or audit against that specific technology standard (to satisfy legal requirements, maintain certification or to identify improvement opportunities). Consequently, the number of different types of audits and appraisals organizations need to perform are growing. Organizations therefore need to look for approaches to performing the needed audits and appraisals more efficiently and to look for ways to combine audits and appraisals (or re-use results across technologies) in order to achieve significant cost reductions. Some organizations have made significant progress in performing appraisals in a more efficient manner, indeed using one improvement technology to improve the appraisal methodology of another [Hefner 2001].

Let us, for a moment, consider the circumstances prevalent in the automobile industry in respect to audits and appraisals. This industry has evolved a structure where a relatively small number of car manufacturers draw the components and expertise for the products they integrate on the assembly line from a somewhat larger group of direct suppliers. These direct suppliers rely in turn on components and expertise from second- and third-tier suppliers. This structure results from the desire on the car manufacturer's part to reduce significantly the number of suppliers they interact with directly. This has the consequence that the car manufacturers, and indeed the direct suppliers, have a greater reliance on their suppliers for essential components. As image is so essential to the appeal of a car manufacturer in its market, the impact poor quality in the supply chain can have on the image of a car manufacturer is critical. In response to this risk, car manufacturer, and in turn, direct suppliers, have turned to a series of technologies including CMMI, SPICE, Auto-SPICE, Lean, Six Sigma and others to provide reassurance that the organizations from which they source critical components have a demonstrable level of competence and capability in the multitude of expertise areas they require. Thus, both car manufacturers and the direct suppliers have imposed requirements for process capability, based on a series of different improvement technologies on their suppliers.

In order to verify that the suppliers indeed have the levels of process excellence required, both the imposers of the improvement technologies and the users engage in activities to demonstrate compliance to the required standards. These activities may take the form of SCAMPI A, B, and C appraisals, SPICE assessments, Auto-SPICE assessments, ISO audits and any number of car manufacturer specific audits, to

mention only the most prevalent types. With the exception of the final category, all these activities are also performed because of internal or external requests for compliance. The results of all these very commendable activities are that projects and organizational units are becoming overwhelmed with appraisals, audits and assessments of internal and external origin. This barrage of activities has a serious impact on the operations of these companies and is particularly acute where key projects are working on critical components. The result is that these projects are overwhelmed by internal and external appraisal type activities, further placing these high risk projects under increased schedule pressure.

There are several potential approaches to solving the problems described above that also offer guidance to organizations in multimodel environments in general. They involve addressing the innate efficiency of any individual audit event as well as addressing the usage of single audit events to serve multiple models' audit/appraisal requirements. The approaches address different aspects of improving efficiency and can be applied internally as part of an organization's multimodel process improvement effort. To effect change in the actual appraisal and audit methods, thereby enabling attainment of formal audit results (not just "internal results and gap analysis") in a more efficient manner, organizations and interest groups can work with and influence the model and standard bodies to make their appraisal and audit approaches more interoperable and integrable.

Efficiency in appraisals and audits, and related factors should all be considered when an organization using multiple process improvement models makes the initial decisions about improvement technology selection. Indeed the processes used to perform mission translation, model selection and model composition should include criteria that help select model combinations that are more compatible when process compliance and assurance activities need to be performed later. Where such selection considerations (i.e., audit compatibility) are overridden required by regulatory or business considerations, the improvement organization needs to give early and careful consideration to how it can achieve internal operational efficiency in its execution of appraisals and audits and still meet improvement, reporting and compliance objectives.

As stated earlier, there are costs savings to be realized in both the efficiency of individual audit events or the co-execution of appraisals or audits internally. Efficiencies in single events may be attained through the applications of such methods as Lean to the appraisal preparation and execution [Hefner 2003], [Hefner 2004]. As an example of co-execution, conducting CMMI and ISO 9001:2000 related internal appraisals/audits by integrated or cross-trained teams of CMMI and ISO 9001:2000 experts is a feasible and practical combination. The availability of agreed mappings of the improvement technologies in use in an organization to the organizational processes, as discussed in the 3rd white paper, is a key success factor in this approach and facilitates the development of common questionnaires for independent examination of compliance in projects and organizational units. Experts from other improvement technologies can then analyze the data collected by the cross-trained experts thus reducing the need for large teams of auditors with representatives from every improvement technology.

Just as many of the pitfalls of process improvement in multimodel environments may be alleviated through appropriate training across the different improvement technologies, staff involved in appraisals and audits also benefit from integrated or cross training. This involves training at an appropriate level in other technologies, in the difference in granularity between technologies and in relevant mapping between the technologies. These competencies are a key pre-requisite for the co-execution of appraisals and audits and to a mutual acceptance of results across technologies. Such cross training also enables innovations that may be required, and increases credibility of those who innovate. For example, while some innovation is required, it is possible to combine results from SCAMPI appraisals, ISO audits and SPICE appraisals for example, at least for internal evaluation, strength and weakness identification and assessment of compliance.

It is more difficult to improve efficiency in externally required appraisals and audits than in internally driven ones. For appraisals and audits required by regulatory or compliance bodies or by customers, organizations do not have much say about the type and frequency of evaluations they are subject to. As a result, organizations that are suffering from the frequency of such evaluations turn to model mappings to help them demonstrate compliance from evaluations against one technology against another. While this is a help internally in understanding the relationship between the technologies they are using, it is of little or no utility if the evaluating organization does not recognize the validity of the mappings, the appraisal methods and the results. There are initiatives starting to form, especially in the automotive industry, to get standards bodies to look at possible combined appraisals, mutual or unilateral recognition of other appraisal methods and indeed the sharing of appraisal and audit results within individual industries, where the industry structure encourages such sharing. Success with such initiatives will however depend on the economic necessity within each industry. Where the economic drivers for integration and mutual recognition of appraisal approaches is great enough, industry lobbyists may be able to exert enough pressure on the standard bodies to force the needed change. Thus the solution across broader industry may ultimately rely more on economic and political power than technical knowledge.

MEASUREMENT

Many improvement technologies explicitly address or contain measurement within their scope. And, while harmonization involve reconciling these features in the composition and implementation, measurement infrastructure in fact plays a much more significant role. Measurement activities are not performed to satisfy improvement technologies requirements, but are serve as a governing factor that both guides and motivates improvement in the organization. In fact, measurement, working closely with mission translation serves as an integrating and harmonizing factor across improvement technologies. By knowing what we care about in terms of success measures, we can more effectively decompose our objectives and plans, and align our improvement projects. In practice, we can better prioritize through hypothesizing (or we have the data, quantifying) the contribution of each improvement to the overall success indicators. This helps us make better decisions

about resource allocation, which projects to do and perhaps just as important, which not to do. The measurement function in a harmonized environment should be agnostic about the technologies contributing any particular metric—the focus is on the results achieved.

The measurement activities in a harmonized improvement environment also need to measure the effectiveness of the harmonization activities. We need to be able to quantify whether the expected benefits of harmonization are being realized. The benefits we need to measure are often complex may include:

- Cost reduction through economies of scale for all aspects of model implementation
- Cycle-time reduction for improvement efforts and the realization of performance objectives
- Culture change related to establishment of enterprise processes, measurement systems, and more
- Process robustness to an ever-evolving and dynamic world of models and regulations
- Long-term, robust, and effective organizational approach to technology and model selection
- Ability to deal effectively with different structures and terminology of implemented models
- Cost reduction in relation to audits and assessments for operational units and projects

Economies of scale have also to be achieved for the measurement infrastructure in the harmonized organization. As indicated in the first paragraph on measurement, almost every improvement technology contains some form of measurement component. We absolutely need to avoid establishing as many measurement initiatives and approaches as we have improvement technologies. In a harmonized approach the creation of a integrated measurement infrastructure that supports and enables effective measurement across multiple improvement is a critical and cost effective task. The cultural benefits an organization derives from a harmonized measurement infrastructure should also not be underestimated. Having a measurements focus as an integral part of your product and process development activities fosters the quantitative approach to reasoning in regard to problem solving in product and process design that is a key element of Six Sigma and the high maturity practices of the Software Engineering Institutes CMMI.

The actual measurement infrastructure installed in an organization will, of necessity, be influenced by the improvement technologies selected for implementation in the organization. The implementation of CMMI in an organization, for example, will be strongly influenced by a concurrent implementation of Six Sigma, if a harmonized approach is followed. Six Sigma provides outstanding analysis methods (it presumes there is already measurement), and in non-manufacturing settings, establishing a measurement infrastructure that often must be an implemented as an "enabling project", providing capabilities to other improvement project later. Six Sigma measurements capability can thus be "baked into" the CMMI practices and may even

be used to improve the improvement effort overall (see Siviy 2007 for a lot of detail on this particular combination). In the software engineering world, we also have Goal-Question-Indicator-Metric (GQIM) and Practical Software and Systems Measurement (PSM). Both are effective for establishing measurement infrastructure. GQIM in particular has a front-end that involves goal decomposition—making it a natural partner of the whole mission translation activities. Also, GQIM has the different indicator types, making it easy to see how to map measures to goals, strategies and tactical plans. As such, it transcends software engineering.

As stated in the white paper, *Maximizing your Process Improvement ROI through Harmonizati*on, from our research observations, the most successful organizations using multiple improvement technologies create a process architecture and accompanying process descriptions—their "corporate way"—and then map the technologies of interest to it. This implemented process is the primary focus of the measurement infrastructure in a harmonized approach, as this process is the one used by the organization to implement the activities, which deliver on the mission, and goals established at strategic levels. The measurement system adjustments needed for a harmonized improvement approach should be minor. If an organization has harmonized their approach to improvement, the measurement system should now also support the organization in determining whether the improvements implemented in the organization are leading to mission fulfillment and goal achievement at the strategic level and deliver the operative units and projects with the information to support the day-to-day running of the operation.

FUTURE RESEARCH

Process improvement groups in the context of multimodel improvement face many implementation challenges separate and distinct from single model improvement. While this white paper identifies an approach to working through these challenges, we realize more research is needed in this area to be able to confidently address the following questions:

- What is our mission? What are our goals? Are we achieving our goals? What stands in our way?
- Which organizational structures best support harmonized process improvement in an organization?
- Are there organizational structures that better suit specific improvement technology combinations?
- What are the advantages/disadvantages of different organizational structures concerning the support they offer to a harmonized approach?
- How do we support /enable effective cooperation and coordination across different organizational improvement technologies?
- What are effective approaches to integrated training and cross-training?
- What are the characteristics and best practices associated with an effective improvement project portfolio management?
- How do we achieve and maintain cost-effectiveness and cost-reduction in regard to the multiple audits and appraisals organization have to conduct?
- How can mutual acceptance of audit and appraisal result be achieved in industries where it has become an acute cost and productivity factor? (How can the standards bodies be influenced to support cross standard efforts?)
- What combination of technologies enable synergy between the measurement infrastructures of the individual technologies?
- What strategies and approaches offer possible best practice for harmonizing measurement infrastructures?

References

The following are the references used in this white paper. Additional reading materials are listed in the "References" and the "Additional Resources" appendices of CMMI & Six Sigma: Partners in Process Improvement. This listing includes both model-specific references (for CMMI & Six Sigma, as well as other combinations) and multimodel references.

URLs are valid as of the publication date of this document.

[Chrissis 2006]

Chrissis, M. B.; Konrad, M; & Shrum, S. CMMI: Guidelines for Process Integration and Product Improvement, 2nd ed. New York: Addison-Wesley, 2006.

[CMMI DEV v1.2]

"CMMI for Development, Version 1.2." SEI Technical Report CMU/SEI-2006-TR-008, 2006.

[GQIM]

Park, Robert E., Wolfhart B. Goethert, and William A. Florac, "Goal-Driven Software Measurement--A Guidebook," SEI Handbook CMU/SEI-96-HB-002, 1996.
http://www.sei.cmu.edu/publications/documents/96.reports/96.hb.002.html

[Hefner 04]

Hefner, Rick, and Dean Caccavo. "CMMI Benefits at Northrop Grumman Mission Systems." SEPG Conference, 2004.

[Hefner 03]

Rick Hefner and Ron Ulrich. "Minimizing SCAMPI Costs via Quantitative Methods." CMMI Users Group Conference, 2003.

[McFeeley 96]

McFeeley, R. IDEAL: A User's Guide for Software Process Improvement (CMU/SEI-96-HB-001, ADA305472). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1996.

[Recardo et al. 07]

Recardo, Ronald, Kathleen Molloy, and James Pellegrino. "How the Learning Organization Manages Change." National Productivity Review 15, no. 1 (January 17, 2007): 7–13.

[Siviy 07]

Jeannine M. Siviy, M. Lynn Penn, & Robert W. Stoddard. CMMI & Six Sigma: Partners in Process Improvement, Addison-Wesley, December 2007.